CHEP2022

XENONnT 实验进展

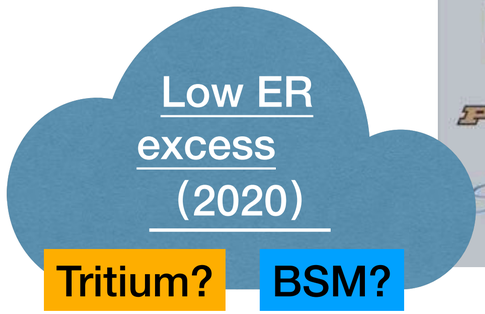
First results on Electronic Recoil Events

刘可欣　清华大学物理系

On Behalf of XENON Collaboration

Progress of XENONnT

- 1. XENONnT upgrades
  - New systems ✅
- 2. First Science Run Data Analysis
  - Blinded analysis 🙈
- 3. Search for the XENON1T excess 🔍
  - Limit on new physics



The XENON Detectors

Detector	XENON10	XENON100	XENON1T	XENONnT
Operation Time	2005-2007	2008-2016	2012-2019	2020-2026
XENON volumn	14 kg	62 kg	2 t	**~6 t, 8.6t**
Sensitivity	$10^{-43} cm^2$	$10^{-45} cm^2$	$10^{-47} cm^2$	$1.4 \times 10^{-48} cm^2$
ER bkg Level events/(keV·t·y)	~2000000	1800	82	**16.1**

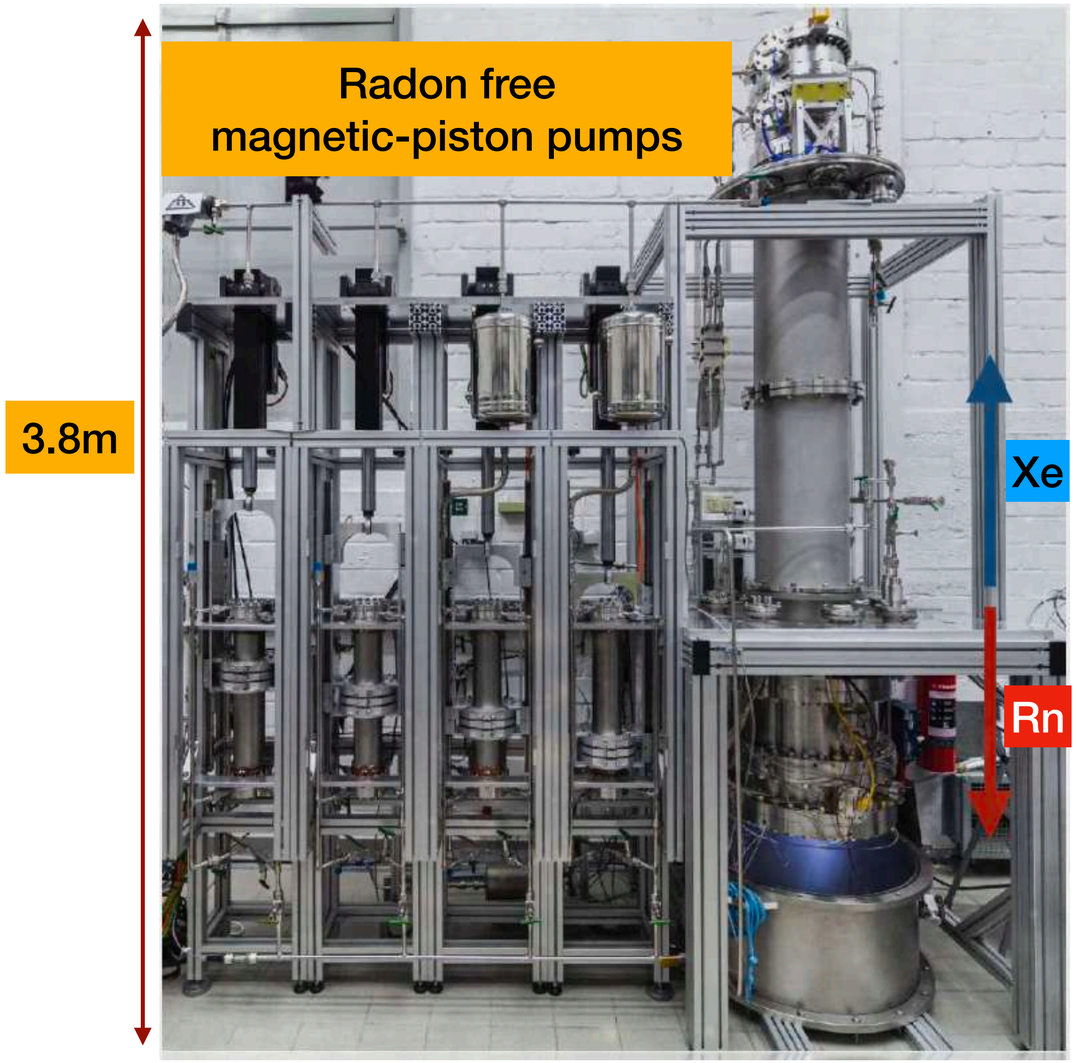
XENON1T -> XENONnT upgrades

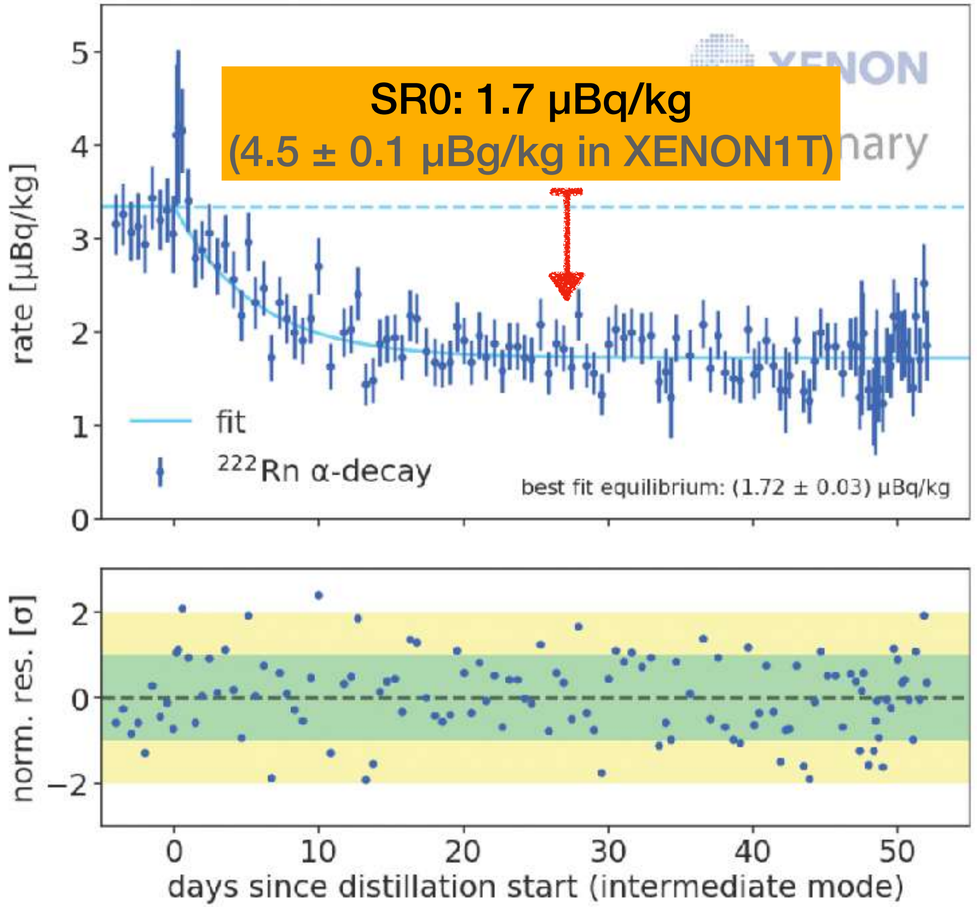
* **Larger TPC and inner cryostat**
* **New purification and distillation system：**
  * **Radon Distillation**
  * **Liquid Xe Purification**
* **Improved cleanliness and radio purity**
* Additional water Cherenkov neutron-veto
* New calibration systems and techniques
* New analysis software package STRAXEN and trigger-less data acquisition

➡️ **Lower bkg, larger mass**

The Radon Distillation System

- Rn222 is the primary source of background events in both XENON1T and XENONnT
- In SR0 operated in gas-mode; would reach **<1 µBq/kg** for SR1+ in liquid+gas mode

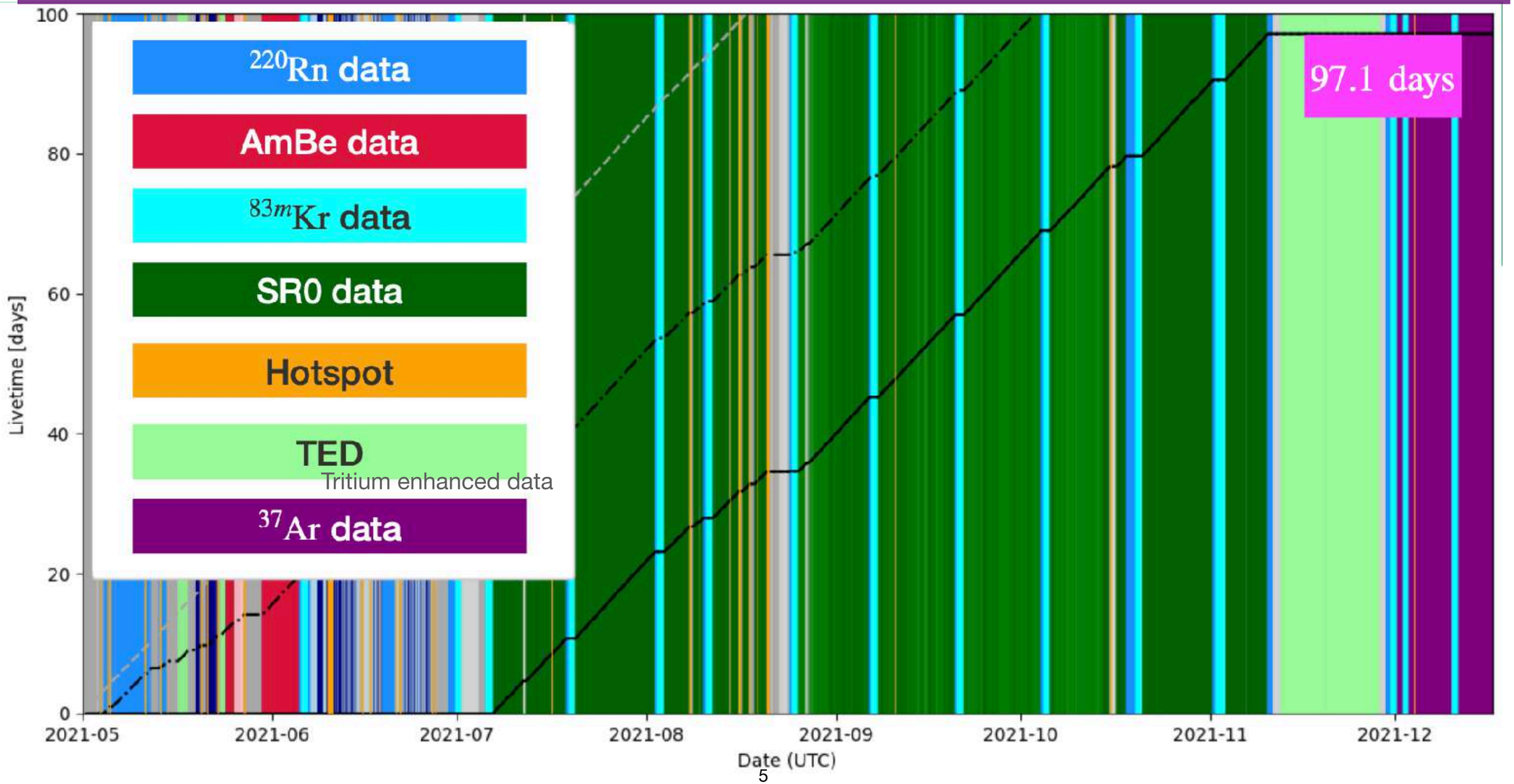




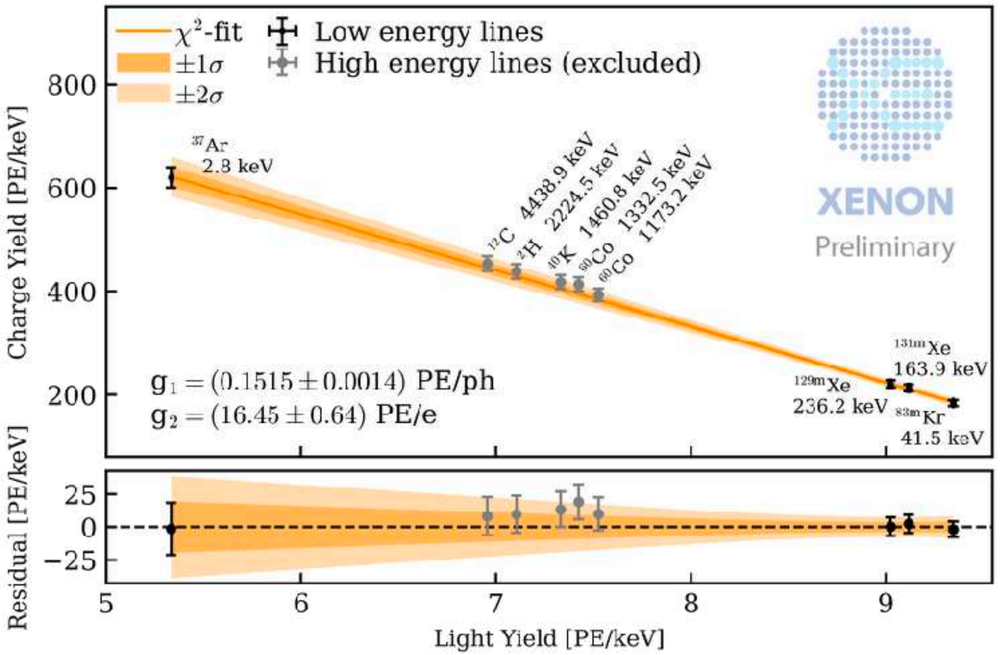
M. Murra, D. Schulte, C. Huhmann, C. Weinheimer
arXiv:2205.11492 [physics.ins-det]

First Science Run - XENONnT SR0

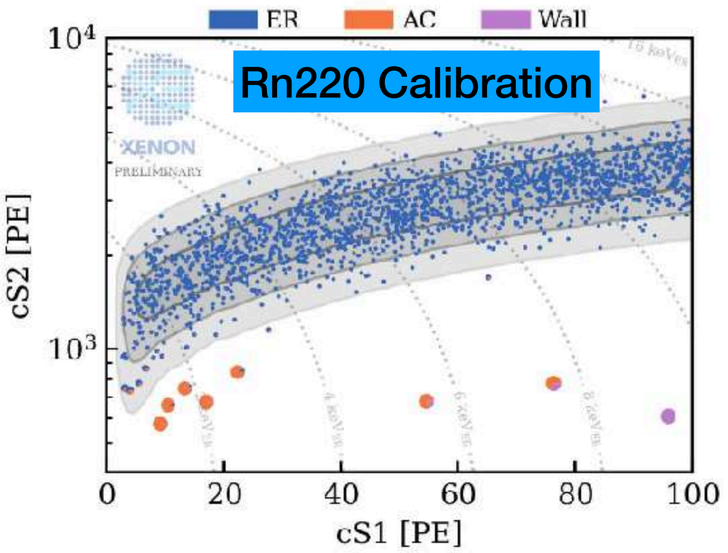
- 97.1 days exposure from July 6th-Nov 11th 2021
- 23 V/cm drift field, Extraction Field in LXe 2.9 kV/ cm
- All but 17 PMTs working, gain stable at 3%



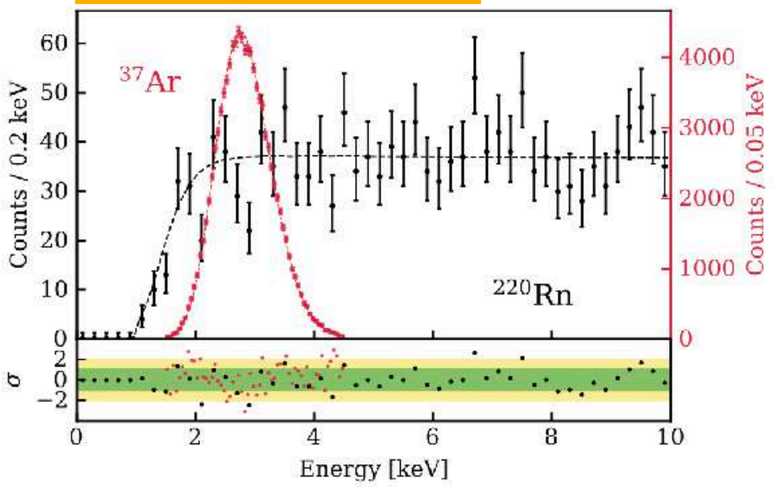
Calibration Low Energy ER Response



$$E = W(cS1/g_1 + cS2/g_2)$$



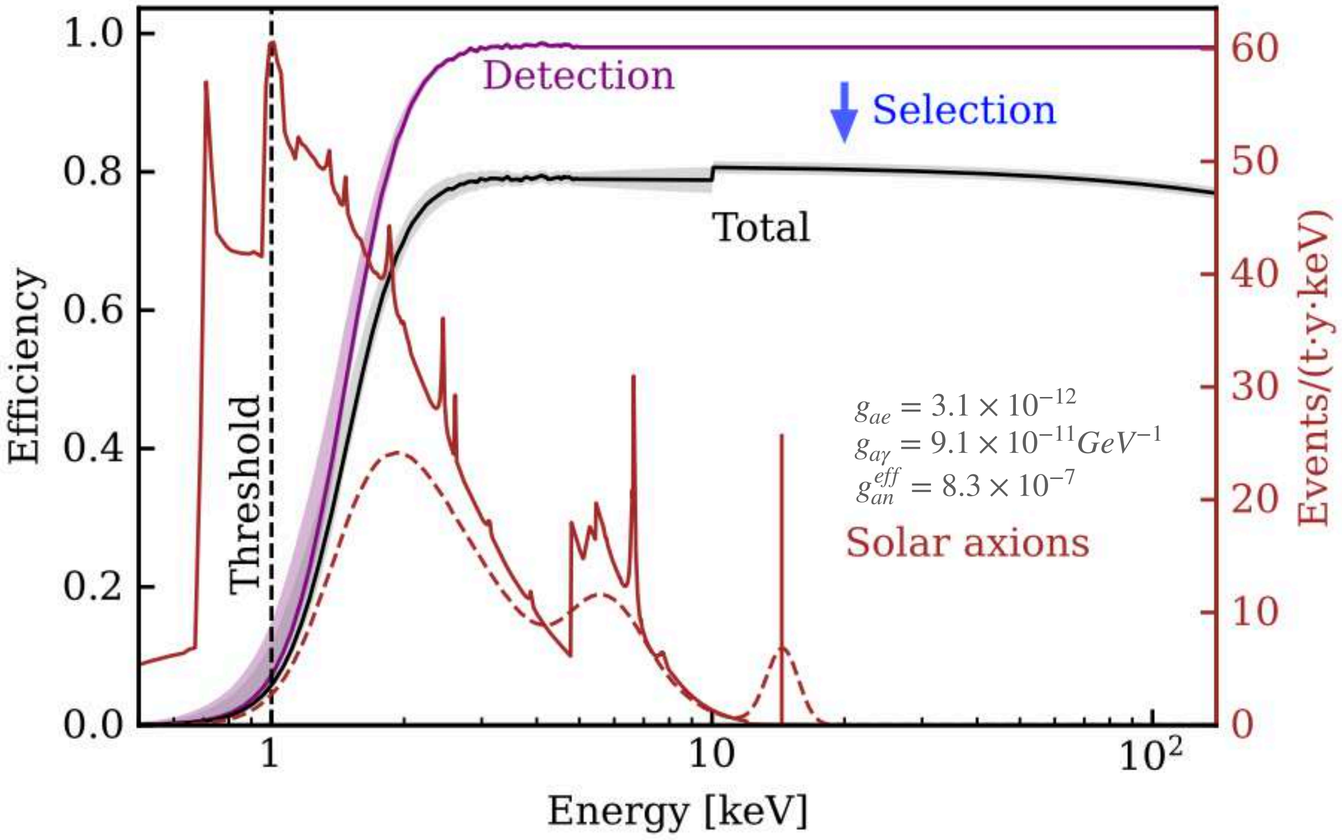
Rn & Ar for lowE ER



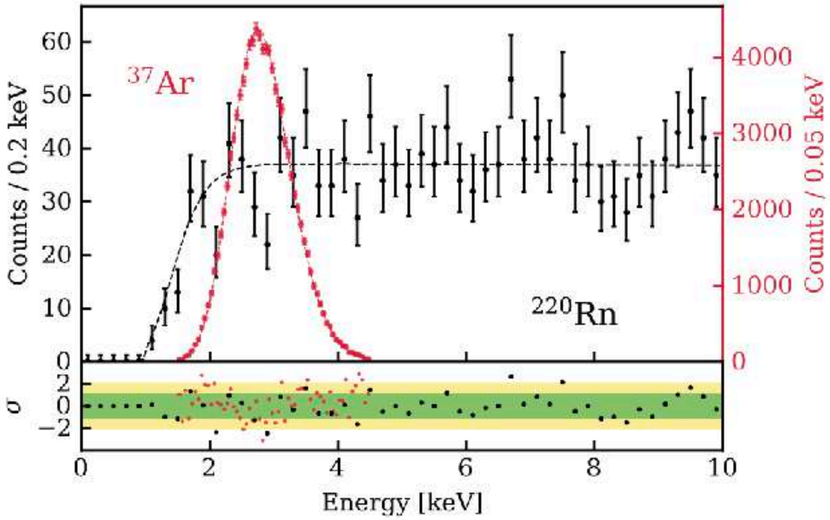
* Ar37, Kr83m, Xe131m, Xe129m are used for low energy analysis
* Rn data shows the efficiency near energy threshold
* Ar data validate the energy reconstruction and signal model

ER Events selection and detection efficiency

Average total cut acceptance: 86%



* (1, 140)keV ROI for LowE analysis
* 70% efficiency at 2 keV



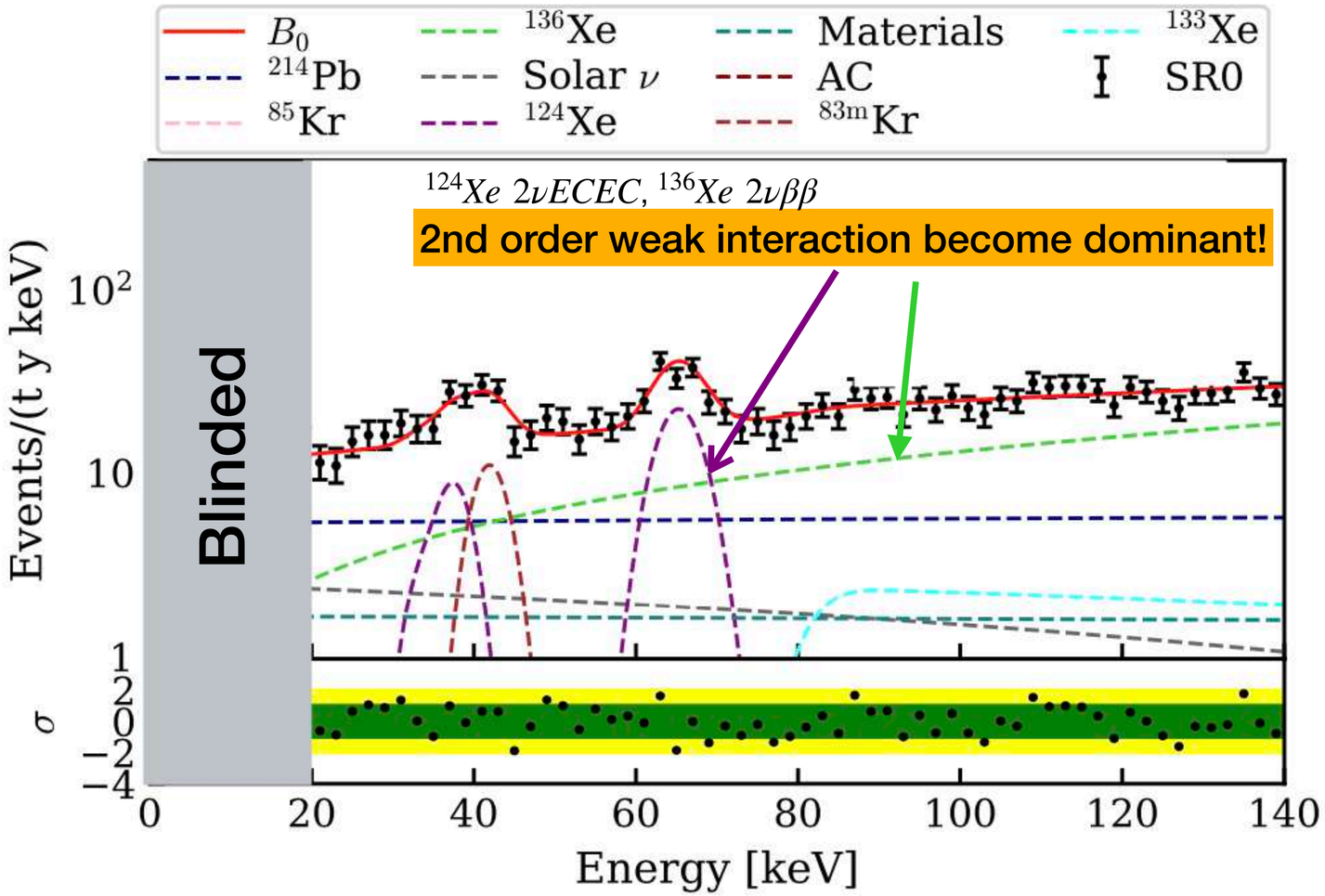
Selection:

* valid S1-S2 pair, single scatter;
* S1 3-fold coincidence
* S2 500PE threshold
* Remove events far from ER region in cS1-cS2 space

Detection Efficiency:

* S1: data-driven and simulation method
* S2: ~100% according to simulation

ER Background Model



	Number of events in ER band	Expected < 10 keV
^{214}Pb	980 ± 120	56 ± 7
^{85}Kr	91 ± 58	5.8 ± 3.7
Materials	267 ± 51	16.2 ± 3.1
^{136}Xe	1523 ± 54	8.7 ± 0.3
Solar neutrino	298 ± 29	24.5 ± 2.4
^{124}Xe	256 ± 28	2.6 ± 0.3
Accidental coincidence	0.71 ± 0.03	0.71 ± 0.03
^{133}Xe	163 ± 63	0
^{83m}Kr	80 ± 16	0

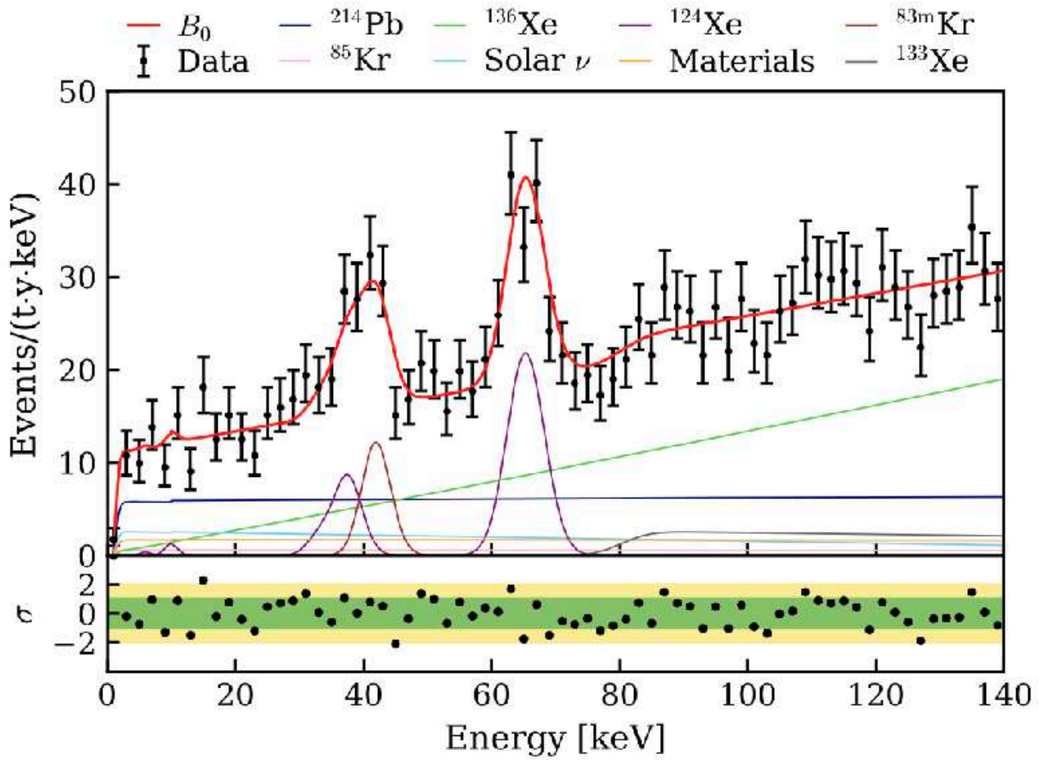
Next talk by Dacheng

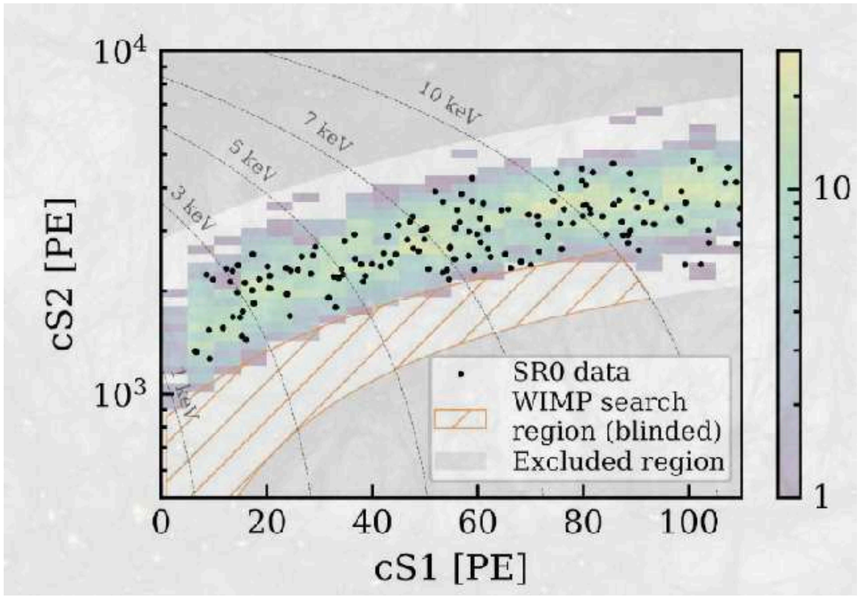
Tritium: negligible
* 3 month outgassing & 3 weeks GXe circulation
* Null result in Tritium enhanced data

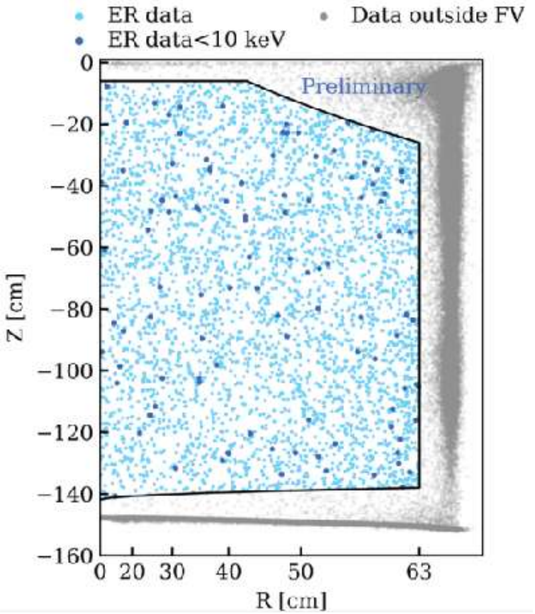
ER Data Unblinded

- region above the -2σ quantile of ER events in S2 unblinded
- 1.16 tonne-year exposure； ER uniformly distributed in FV
- Data agree with the background only model

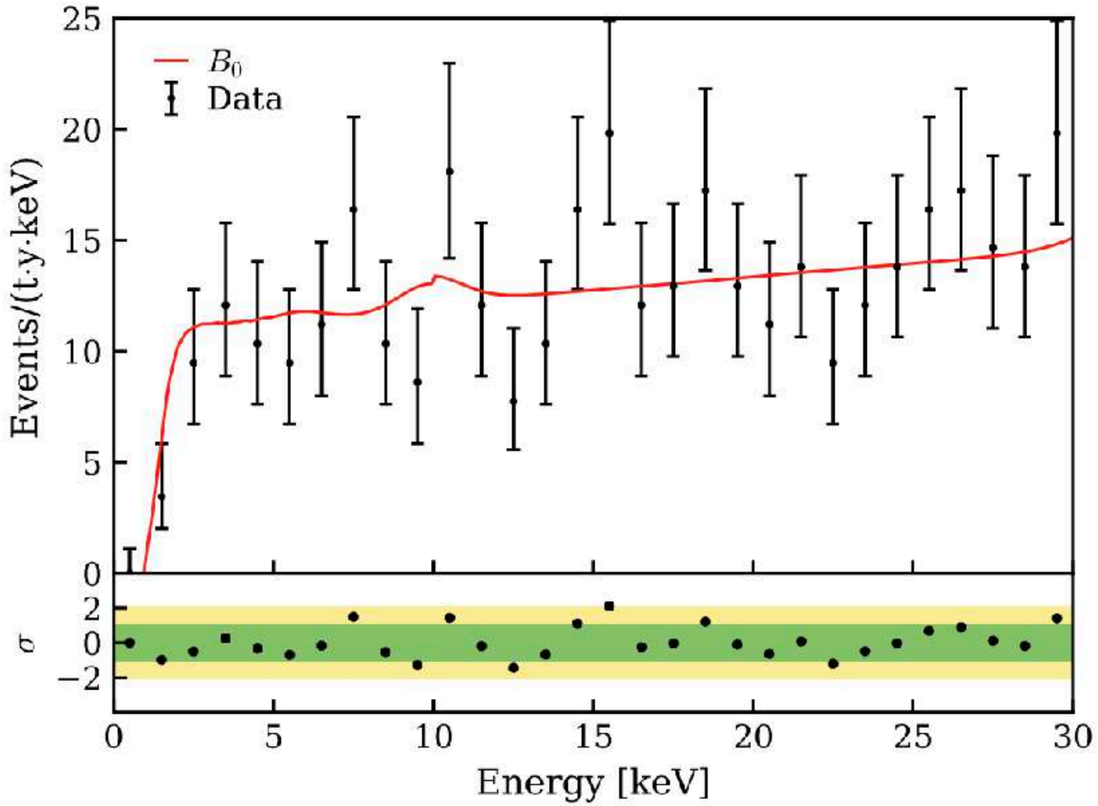
"Search for New Physics in Electronic Recoil Data from XENONnT."
http://arxiv.org/abs/2207.11330.

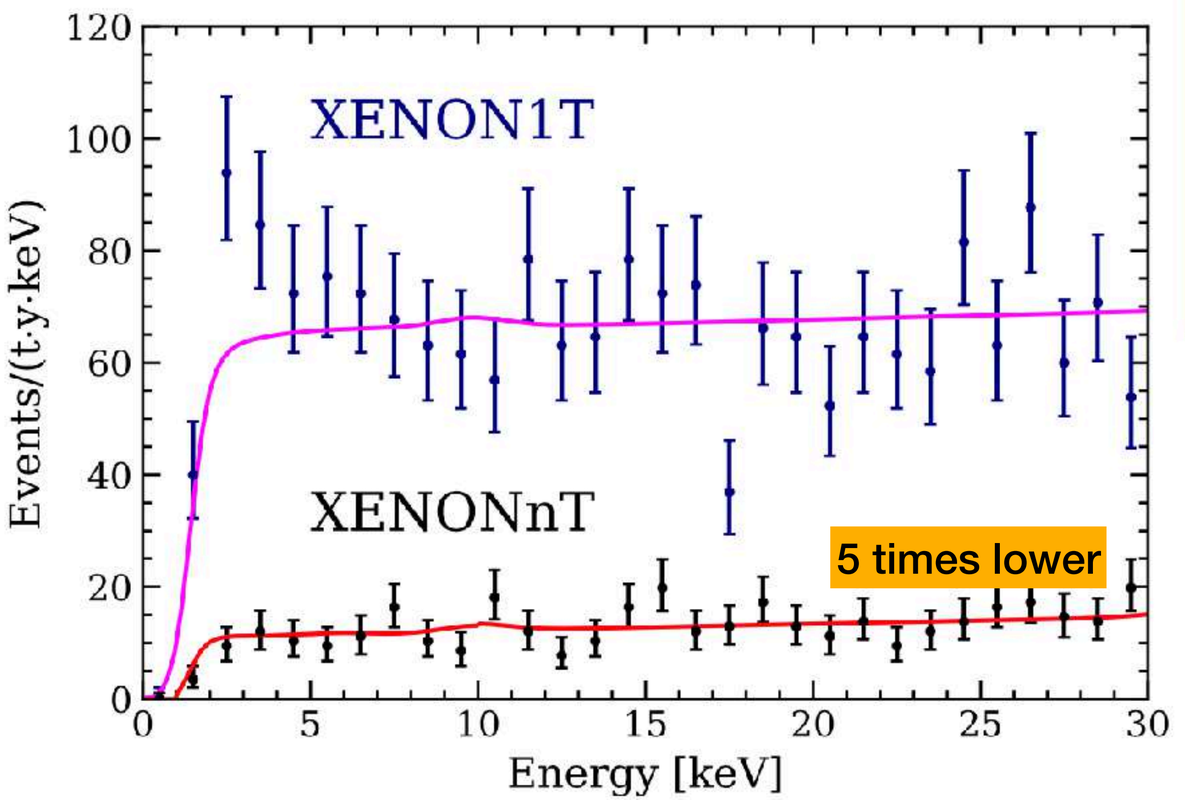






LowER Excess Searching Result



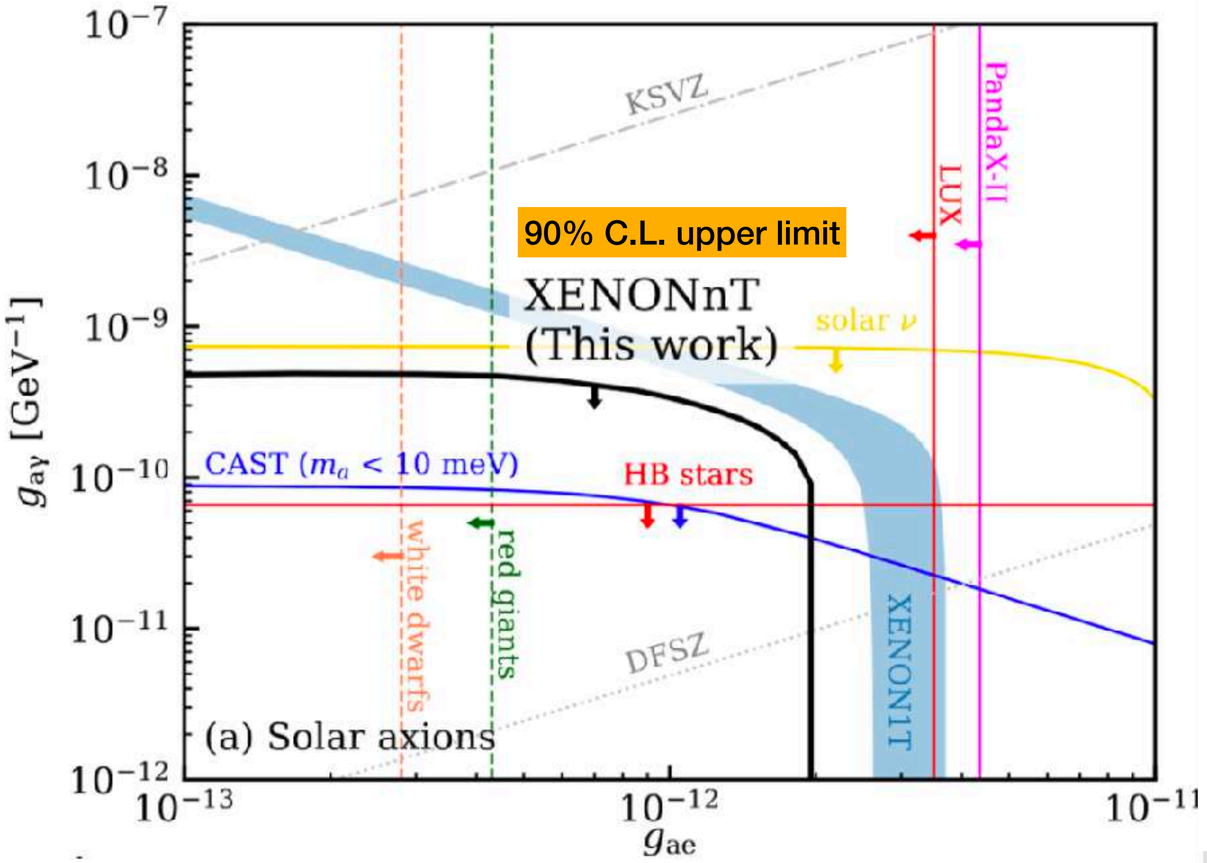


- Average Background 16.1 events/(t·y·kev), 1/5 of XENON1T
- Exclusion of XENON1T excess (2.3 keV) peak at ~4σ

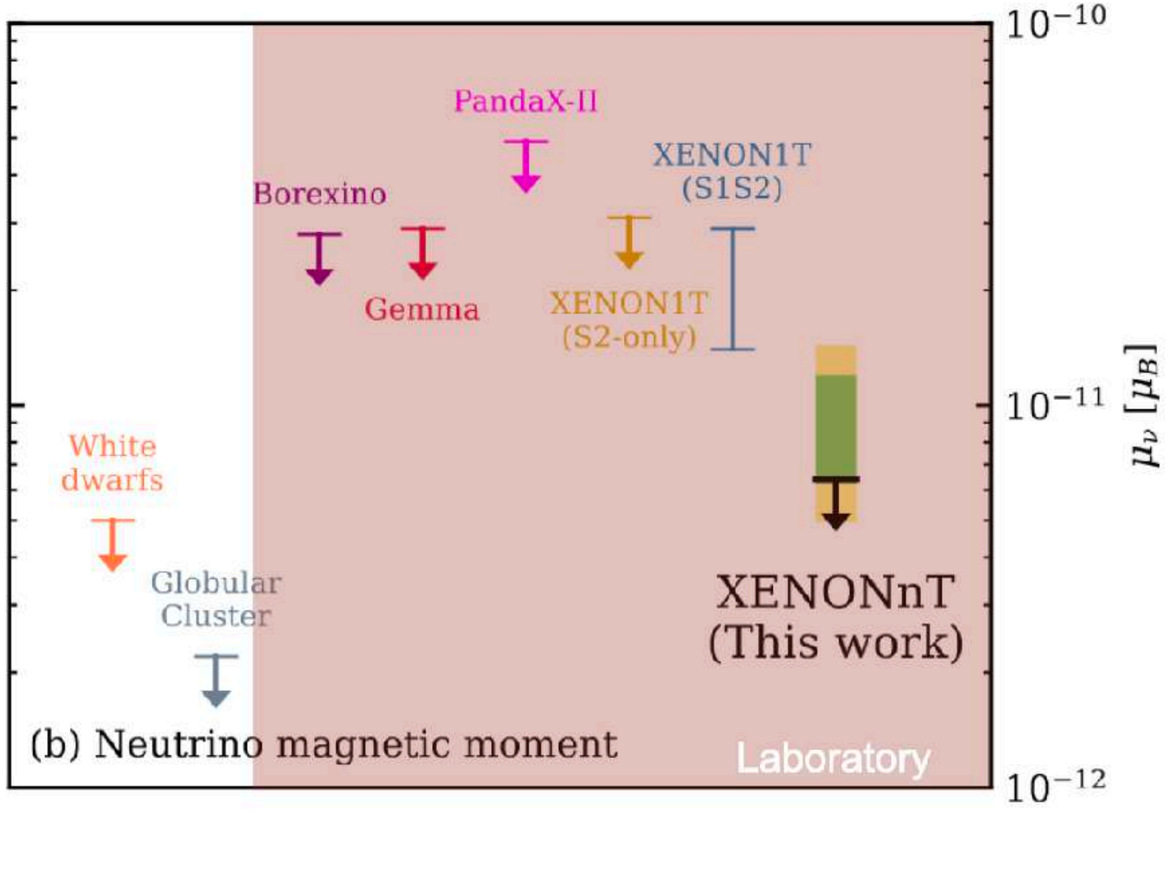
The most likely explanation of XENON1T excess is trace amount of ^3H.

Set Strict Limit on New Physics

Solar Axions



Neutrino magnetic moment

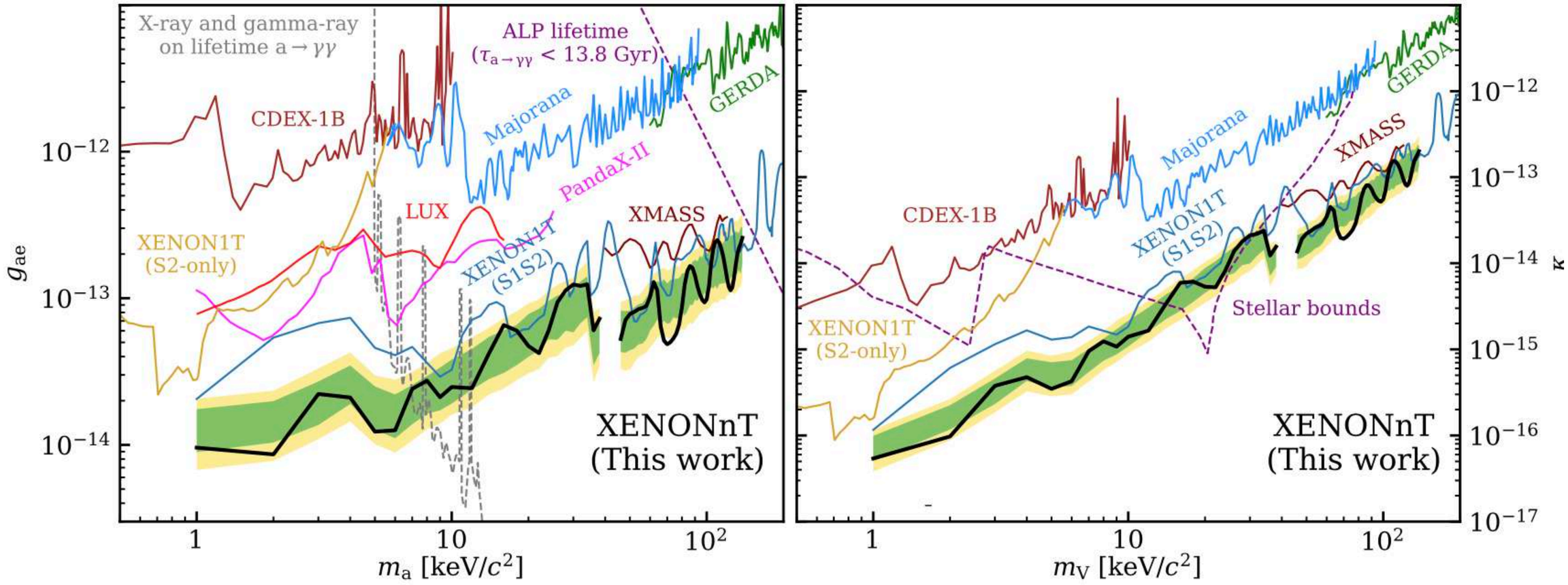


Set Strict Limit on New physics

Bosonic DM

Axion-like particle

Dark Photon

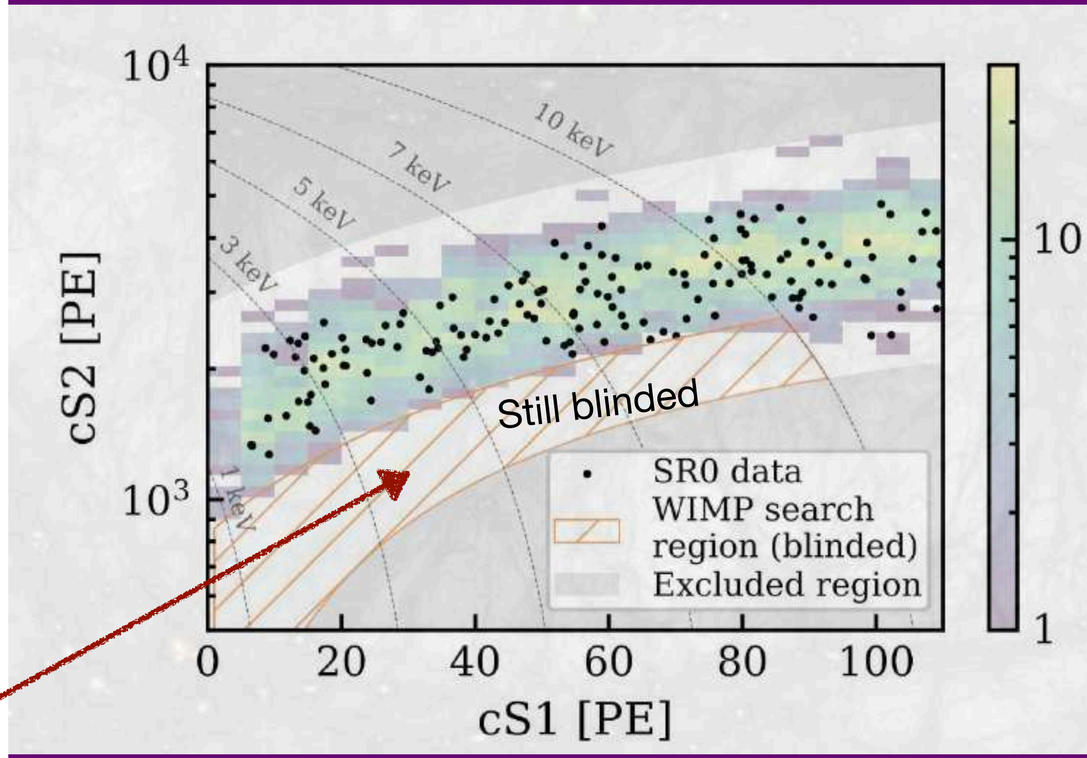


Summary

- XENONnT achieves excellent background levels and xenon purity

- ER analysis **rejected** a XENON1T-like excess, and set new constraints on new physics models

- NR unblinding and **WIMP analysis** ongoing!



Thanks!💗